

SOLUTION STOICHIOMETRY QUIZ

1. 12.5 g of copper metal is reacted with 5.00 mL of 8.00 mol/L nitric acid, according to the following:



12.5 g 5.00 ml
8.00 mol/L

- a) What is the limiting reactant? [5 marks]

$$n_{\text{Cu}} = 12.5 \text{ g} \times \frac{1 \text{ mol}}{63.55 \text{ g/mol}} = 0.197 \text{ mol (available)}$$

$$n_{\text{HNO}_3} = \frac{8.00 \text{ mol}}{\text{L}} \times 0.005 \text{ L} = 0.04 \text{ mol (available)}$$

$$n_{\text{Cu}}(\text{reacted}) = 0.04 \text{ mol HNO}_3 \times \frac{3 \text{ mol Cu}}{8 \text{ mol HNO}_3} = 0.015 \text{ Cu (reacted)}$$

$$\therefore n_{\text{Cu}}(\text{available}) > n_{\text{Cu}}(\text{reacted}) \quad \therefore \text{Copper is the excess reagent}$$

0.197 mol 0.015 mol

$\therefore \text{HNO}_3$ is the limiting reagent

- b) Calculate the mass of the nitrogen monoxide formed. [3 marks]

$$n_{\text{HNO}_3} = 0.04 \text{ mol}$$

$$0.04 \text{ mol HNO}_3 \text{ (aq)} \times \frac{2 \text{ mol NO(g)}}{8 \text{ mol HNO}_3 \text{ (aq)}} = 0.01 \text{ mol NO(g) produced}$$

$$m = nMM$$

$$m_{\text{NO}} = 0.01 \text{ mol NO} \times 30.01 \text{ g/mol} = 0.300 \text{ g produced}$$

- c) Calculate the concentration of the aqueous solution that will be produced. [4 marks]

$$n_{\text{HNO}_3} = 0.04 \text{ mol}$$

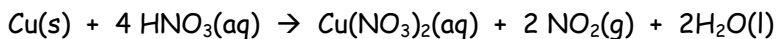
$$0.04 \text{ mol HNO}_3 \text{ (aq)} \times \frac{3 \text{ mol Cu(NO}_3)_2 \text{ (aq)}}{8 \text{ mol HNO}_3 \text{ (aq)}} = 0.015 \text{ mol Cu(NO}_3)_2 \text{ (aq) produced}$$

$$C = n / v \quad n = 0.015 \text{ mol} \quad v = 0.005 \text{ L}$$

$$C_{\text{Cu(NO}_3)_2} = \frac{0.015 \text{ mol}}{0.005 \text{ L}} = 3.00 \text{ mol/L}$$

Name: _____

2. 500 g of copper metal is reacted with 2.5 L of 3.0 mol/L nitric acid solution. Calculate how much of the copper metal remains after the reaction is complete. [7 marks]



500 g 2.5 L
 3.0 mol/L

$$n_{\text{Cu}} = 500 \text{ g} \times \frac{1 \text{ mol}}{63.55 \text{ g}} = 7.8678 \text{ mol (available)}$$

$$\begin{aligned} n_{\text{HNO}_3} &= CV \\ &= 3.0 \text{ mol / L} \times 2.5 \text{ L} \\ &= 7.5 \text{ mol (available)} \end{aligned}$$

(limiting reagent, since question says some copper remains unreacted, but we will verify this later on)

$$n_{\text{Cu}} = 7.5 \text{ mol HNO}_3 \times \frac{1 \text{ mol Cu}}{4 \text{ mol HNO}_3} = 1.875 \text{ mol (reacted)}$$

$$n_{\text{Cu}} (\text{available}) > n_{\text{Cu}} (\text{reacted})$$

$$\begin{aligned} n_{\text{Cu}} (\text{remained}) &= n_{\text{Cu}} (\text{available}) - n_{\text{Cu}} (\text{reacted}) \\ &= 7.868 \text{ mol} - 1.875 \text{ mol} \\ &= 5.993 \text{ mol} \end{aligned}$$

$$m = nMM$$

$$m_{\text{Cu}} (\text{remaining}) = 5.993 \text{ mol} \times 64.55 \text{ g / mol} = 380.84 \text{ g}$$

∴ mass of copper that remains unreacted (expressed to 1 S.D.) is 400 g.